

Comparison Between Variable Rate k-Space Sampling and Sequential k-Space Acquisition with bSSFP and CMT

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Introduction

Detection of systemic diseases, such as peripheral vascular disease and cancer, requires that large anatomical regions be scanned with an extended field-of-view (FOV); something that is not easily achieved with conventional MR scanners. The magnetization achieved during balanced steady-state free precession (bSSFP) pulse sequences requires time to achieve a steady-state.[1] During continuously moving-table (CMT) [2,3] large FOV imaging, unexcited tissue is continually moved into the local FOV. Furthermore, the CMT method used by this institution involves acquiring the data in a partially-sampled hybrid k-space.[3] The combination of bSSFP with CMT acquisition thus has the potential for adversely affecting overall image quality. Our purpose was to determine whether a variable rate k-space sampling method (in which the centre of k-space is acquired more frequently, see [4]) or a sequential k-space acquisition provides better overall image quality at a given table velocity.

Methods

CMT bSSFP images were collected using both (a) variable rate k-space sampling and (b) sequential acquisition methods. Healthy volunteers were scanned on a 3 T clinical MR scanner (Signa; General Electric Healthcare, Waukesha, WI) equipped with a body coil. The bSSFP sequence parameters were: a flip angle of 35°, a TR/TE of 3.1 ms/1.6 ms and a 5-mm slice thickness. First, the table velocity was varied from 1 cm/s to 4 cm/s with the variable rate k-space sampling method, in order to determine the optimal table velocity based on degree of k-space coverage and overall image quality. Two acquisitions were then collected at the optimal table velocity using both the variable rate k-space sampling and sequential methods with parameters set to yield approximately equal k-space coverage. The overall image quality was assessed by (a) subtracting the images from one another and inspecting differences, (b) the degree of partial k-space coverage, and (c) assessment of signal intensity profiles through the images.

Results

It was initially determined that the optimal table speed was approximately 1 cm/s (the slowest reliably achievable speed with manually controlled motion). Representative images from both k-space acquisition methods from one volunteer collected at a table speed of 1 cm/s are shown in the Figure. Figure (a) was collected using a variable rate k-space sampling method and Figure (b) was collected using a sequential method. The absolute difference image (Figure c) showed no distinct difference between the two images, other than due to subject motion between scans. The partial k-space coverages were 9.3% and 10.6% for the variable rate k-space sampling and sequential methods, respectively. The signal intensity profiles did not show any major difference between the two images.

Discussion and Conclusions

As expected, the overall image quality improved with slower table speed. Because the operator controlled the motion, table speeds of less than 1 cm/s were not reliably achievable.

Furthermore, there did not appear to be a significant difference in overall image quality between the variable rate k-space sampling and sequential k-space acquisition methods at a given table velocity. Because the bSSFP technique does not involve the injection of a contrast agent, a rapid refresh rate was not necessary to follow any contrast kinetics. Also, the table motion is not limited by the arterial phase of the contrast agent, and thus the table can be moved slowly to allow for higher k-space coverage. Therefore, we conclude that sequential k-space sampling is as effective as variable rate k-space sampling during bSSFP CMT imaging.

References

[1] A Oppelt *et al. Electromed* 1986; **54**: 15.

[2] DG Kruger *et al. Magn Reson Med* 2002; **47**: 224.

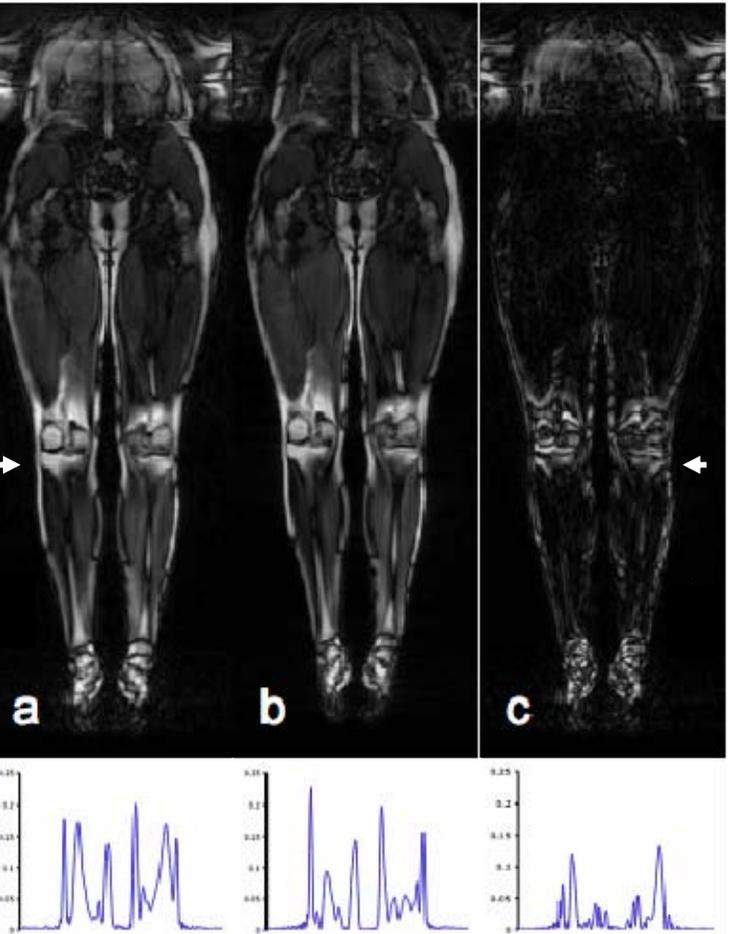


Figure: Large FOV bSSFP CMT images collected at 1 cm/s with (a) variable rate k-space sampling and (b) sequential k-space acquisition methods. The corresponding signal intensity profiles are shown below each image. The absolute difference image is shown in (c), along with the corresponding absolute difference in the intensity profile (indicated by arrows).

[3] M Sabati *et al. Phys Med Biol* 2003; **48**: 2739.

[4] FR Korosec *et al. Magn Reson Med* 1996; **36**: 345.